

**Studying Teachers' Opinions about the Use of Pixel Spreadsheet to Teach Computing
Literacy**

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by

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**Studying Teachers' Opinions about the Use of Pixel Spreadsheet to Teach Computing
Literacy**

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LIST OF SYMBOLS AND ABBREVIATIONS

STEM	Science, Technology, Engineering, and Math
RGB	Red, Green, and Blue

SUMMARY

Many factors play into the reasons why there is such a mass underrepresentation of minority students in the computer science field in middle and high schools, such as course offerings, student-teacher ratios, and student-teacher expectations. The focus of this study, however, is improving the computing literacy of the teachers. Students need confident and qualified instructors to teach them computing concepts, for the skills that they learn will benefit them in any field they choose to study. In order to pass knowledge onto students, we will need to educate instructors first and foremost. This study looks at how scaffolding can play a role in helping a participant to construct new knowledge structures and improve on existing structures. Scaffolding provides prompts to assist users with technology to provide clearer instructions for the tasks they set out to complete.

In this particular study, scaffolding takes the form of the three tutorial videos that the participant will view in order to perform the tasks provided. We use two methods of scaffolding. The first is “black-box,” which leaves users heavily dependent on the scaffold. The participants would later become less dependent on the videos (therefore allowing the scaffolding to fade away) and the new prompts for tasks will become the second method of “glass-box” scaffolding; scaffolding that allows the participant to construct new knowledge structures and improve on existing structures. The knowledge the participant gained from the videos affects how they will perform in future tasks. Transforming the scaffolding videos from black-box to glass-box, and allowing the glass box to fade is the main goal of the study.

CHAPTER 1

INTRODUCTION

Since school curriculums use simplified versions and routes to solve different problems, not many students receive the type of education they need to excel in the real world (Guzdial, 1996). Students need support in order to solve those complex problems, and that support is called “scaffolding”. Scaffolding comes in two types: black-box and glass-box. There is a difference between the two, yet both methods are needed in this study. Black-box scaffolding focuses on the performance aspect of a concept; it teaches a student to learn how to perform a task but does not explain why it is being performed. Glass-box scaffolding enables both performance and understanding (Guzdial, 1996). The purpose of this research is to improve the computing literacy of the faculty by finding new ways to teach introductory computer science concepts without programming, through the use of both scaffolding techniques.

The program used in this study was called PixelSpreadsheet. It is an data abstraction tool that uses spreadsheets to display image information. The information is stored in five columns, three of which indicate each an RGB color channel (red, blue, and green). The other two columns contain coordinate values X and Y to indicate the position of that particular piece of information. That single piece of information, called a pixel, makes up only one part of the image. Users would be able to easily manipulate images with the program, without having any prior experience with computer science. With PixelSpreadsheet, teachers would be able to explain to students how RGB channels make up pixel colors, and how pixels can make up an image.

We conducted this research when high school teachers were on Georgia Tech's campus for a summer professional development workshop. They were handed a flyer during the workshop about the study. At one of the breaks, participants were told (by the

workshop staff) when and where (what room on campus) teachers could go to participate in the study. Teachers were given the consent form, and study staff offered to answer any questions. As consent forms were turned in, participants were given a number that was used to identify them throughout the rest of the study, so that no direct connection could be made between participants and their personal information. We did not record the number on their consent form, so that no name-number associations would exist. Participants were seated at a study laptop (with a number matching their ID number). They were asked to fill out the demographic and prior experience survey. We reminded the participants that participation in the study was completely voluntary. The laptops were running Windows with HyperCam installed to gather information on how participants used PixelSpreadsheet. They were notified that the computers were recording their session. We asked the participants to view three videos (each no more than five minutes long) and then complete tasks related to that video. Before each video, we reminded the participants that participation in the study was completely voluntary. Study staff was available to answer questions throughout the study. Each video described the use of a tool called Pixel Spreadsheet, which converts images to a spreadsheet (describing each individual pixel and its colors), and supports conversion back to an image. Each video presented a worked example of use of PixelSpreadsheet to complete some image manipulation, such as negating an image or rotating an image. Participants were asked to perform a task after each video. The task was either be a direct replication of an operation on the video, or was similar to one to answer a question based on the video. After the study, the participants completed a survey on how well the tool would work in a classroom setting.

Literature Review

Stuck in the Shallow End (Margolis, 2008) shows readers that the schools that were studied (three high schools in the Los Angeles area), only two of them offered

computing classes, and they often taught low-level introductory material (such as learning how to type, copy and pasting). The problem with those classes is that there are no classes beyond that, ones that teach algorithms or data structures that are employed in a number of ways beyond schooling. In 1998, 55-57% of all students initially majored in STEM fields (Anderson, Kim 2006). However, over the course of the next four years, the number of students receiving STEM degrees in a timely manner varied by racial groups. By 2001, only 62.5 percent of African American and Hispanic students who had majored in the STEM fields in 1998 obtained their degree in that area, lower than the rate of White students and Asian students at 86.7 percent and 94.8 percent respectively. Anderson and Kim noted that “the majority of those who did not obtain a STEM degree had not dropped out; they were still enrolled and working toward a degree, but at a much slower pace.”

In many high schools, there are no advanced classes because there is not enough interest or enough teachers qualified to teach those classes. Even though teachers and students have physical access to computers does not mean they know how to use them on a higher level. Students require qualified instructors to teach them computer science concepts. Even if some of the students do not wish to continue their education in computer science, the skills they have learned will benefit them in any field. In order to pass knowledge onto students, we will need to educate the instructors. A process called “scaffolding” can aid in teaching new concepts to learners. In computer science, a lot of learning comes from seeing and completing tasks in order. Scaffolding supports the “learning-by-doing” method of teaching (Guzdial, 1996). Two different types of scaffolding can be implemented during the course of the teaching process, and they are called black box and glass box scaffolding. While the black box facilitates the performance part of an experiment, it does not help with the retention of information.

Glass box scaffolding enables both performance and understanding (Guzdial, 1996).

Learning how to combine both scaffolding structures may help in the creation of software that itself can facilitate the process of performing a task, solving it, and learning from it.

From scaffolding, we can measure how technologies can support performance and develop people's problem solving skills (Salomon, 1991). By examining the relationship between technology and people, we can gauge how effective this strategy was in teaching the necessary information to the teachers so that they can in turn pass this knowledge on to their students.

CHAPTER 2

METHODS AND MATERIALS

As stated before, the focus of the study is to improve the computing literacy of the faculty. One must know how to do something before he or she can teach it.

Pre-surveys and demographic surveys were used to gauge the level of familiarity with the programs used in the study and provide background information for the participants.

PixelSpreadsheet works in tandem with a spreadsheet program. In this study, LibreOffice's Calc program was used; it is a program similar to Microsoft Excel. We had to use LibreOffice's Calc program because the computers used in the study did not have Microsoft Excel installed. The spreadsheet program is where the bulk of the work will be performed; the calculations must be done in the spreadsheet. In addition, task sheets were passed out to each participant so that they could document what tasks they finished. A screen capturing program called HyperCam was employed here to provide a more in-depth look into the performance of each participant. Lastly, post-surveys were given after an hour.

Each participant was given the same set of tasks to perform and was required to check off each task after it was completed. The tasks required the participants to watch and learn from the tutorial videos, then perform some identical or similar task. The videos produced during my research provide the scaffolding the participants need to perform the task. Each video contained elements of both black and glass-box scaffolding in order to assist the participant. For example, the second video demonstrated how to make a negative image. The participant had to replicate the task in order to understand how to do it (black-box), and afterwards must rotate the negative image, a skill learned from the first video (glass-box). Each part of the study was timed, from watching the videos to performing the tasks. After the study was over, participants were asked to fill out a post-

survey to describe their experience with the program. Screen capturing the participants' laptop screen, along with the post-survey answers, aided in analyzing the effectiveness of the videos and program.

For the pre-survey, questions were asked to give more insight about how the teachers performed during the study. The questions asked are:

- Why do you, personally, use Microsoft Excel for?
- Have you heard of PixelSpreadsheet before this study? If so, what do you know about it?
- Do you have previous experience with image manipulation?
- What do you teach?

These questions aided in analyzing the performance and reasons for performance at the end of the study.

After the pre-surveys were given, participants started the process of learning PixelSpreadsheet.

Participant Task Sheet

Number: _____

1. Please watch Video 1

Then try to use PixelSpreadsheet to:

a. Flip the x and y coordinates for a picture of your choice.

To save a CSV file in LibreOffice Calc:

-Save As> Edit Filter Settings> Use CSV format> Uncheck the "Save Cell Content As Shown" Box

☐ COMPLETED

2. Please watch Video 5

Then try to use PixelSpreadsheet to:

a. Make a negative image of any picture you want.

b. Make a rotated negative (combining the task for Video 1 and this one).

To save a CSV file in LibreOffice Calc:

-Save As> Edit Filter Settings> Use CSV format> Uncheck the "Save Cell Content As Shown" Box

☐ COMPLETED

3. Please watch Video 3

Then try to use PixelSpreadsheet to:

a. Use the IF function to modify a picture so that the red value is zeroed for only the top half of a picture.

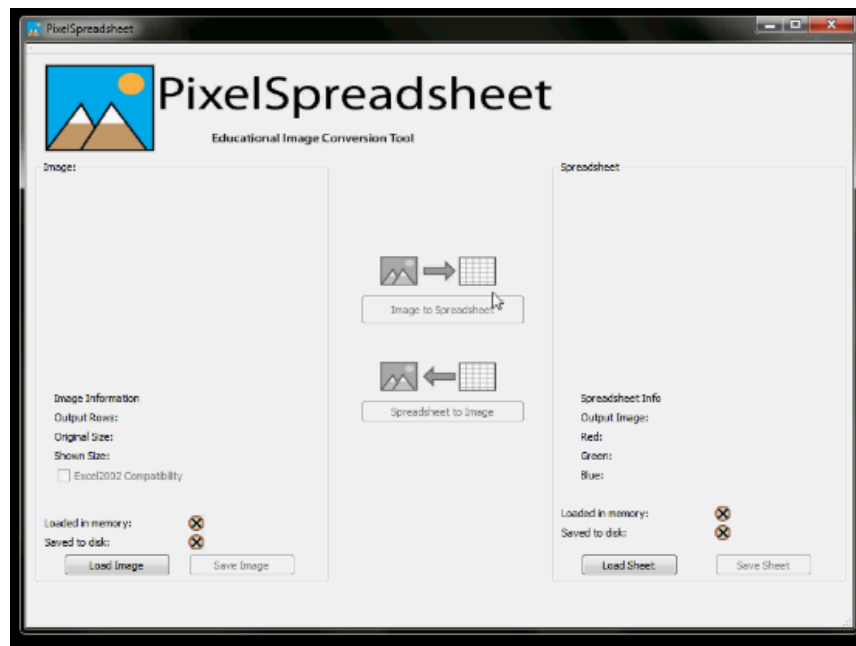
To save a CSV file in LibreOffice Calc:

-Save As> Edit Filter Settings> Use CSV format> Uncheck the "Save Cell Content As Shown" Box

☐ COMPLETED

Figure 1. The sheet that was given to the participants outlined the tasks that they were required to perform during the study. Participants were required to view video 1, video 5 and video 3 in that order to accomplish those tasks.

PixelSpreadsheet Interface



Original Image



Result Image



Figure 2, Figure 2.1, Figure 2.2. The original image lies on the left, while the negative image is on the right. This image was produced using PixelSpreadsheet. (The negative image was produced by taking each color column value and subtracting it from 255). The negation of an image task is detailed in the second part of the task sheet.

Each of the video and task completion sessions were timed; no more than five minutes was allotted for the original video-watching session, and no more than fifteen minutes was allotted for each of the tasks. Participants were allowed to look back at the videos during the testing time.

After the testing session ended, participants were presented with post-study survey questions. These questions did not repeat the questions posed by the pre-survey. The post questions were intended to gather feedback on the videos' quality and the program's usability. The questions asked were:

- Were the videos engaging? Were they easy to understand?
- How helpful were the videos in aiding in the completion of the tasks?
- Could you use PixelSpreadsheet in your classes? How might you use it?
- Do you think your students would like using PixelSpreadsheet? What problems might they have with it?
- What do you think your students could learn from using PixelSpreadsheet?
- Please tell us something about PixelSpreadsheet or the videos that we could fix to make them work better for you and your students.

Answers to these questions aided in gauging how well or how effective the videos were, and if the program is ready to be introduced to a classroom setting.

CHAPTER 3

RESULTS

Direct Observation:

During the testing session, I observed two people having trouble with finding the correct place to start in the videos (as in where to find a specific part in the video to help him/her with the assignment). Three participants that I observed had trouble with scrolling and applying values to every cell in a column in LibreOffice. Most of them had trouble with finding a suitable image for the program; the pictures they picked were too large. Every tester reviewed the video multiple times to get through each assigned task.

Pre-Survey Observation:

Most of the teachers have a background in STEM field (computer science and math) (6/8), and the other two were either music education or economics. According to the answers on the survey, most have had experience with image manipulation (6/8), and the ones that did taught computer science (5/6) or mathematics (1/6). None of the participants have heard of Pixelspreadsheet before.

Post Survey Observation:

Seven out of the eight people tested were able to complete two of the three tasks, and (5/8) were able to accomplish all three tasks. Most of the testers thought that the videos were engaging and overall easy to understand; however most had to use the videos throughout each of the tasks repeatedly (start/stop method). While some of the surveys state that they found the instructions to be clear, their students may not find it easy enough to understand. Six out of eight of the surveys said they would be able to incorporate the program into their curriculum, and two out of the eight said that they

would not be able to because the program was “too slow”, and it involved a lot of work. They also mentioned that it would not interest their students. The students wouldn't like it because it involves a lot of work to see the results. One of the surveys noted that students' focus may be challenged; they might find it too hard or too boring. Students may find navigating through Excel to be difficult since one might not have a lot of experience with it. For instance, column manipulation would be the most difficult part of the manipulation process.

CHAPTER 4

DISCUSSION

In order to analyze the results completely and thoroughly, they must be put into the context of answering the original research questions:

- Were the videos engaging and easy to understand?
- How helpful were the videos in the completion of tasks?
- Will teachers use this in the classroom?
- How much did they use the videos when doing the tasks?
- Did the background of the participants influence the results?

So, were the videos engaging and easy to understand? The results gathered from the post-survey say that (6/8) said they were, and (2/8) said they were not. The reason there could be that most of the participants said that they were easy to understand because they reviewed the video multiple times, understanding the task after they had been exposed to it. It wasn't a glass-box structure being built here; the videos still seem to construct a black-box. Even though they did have to review the video over and over again, a majority of them were still able to understand how to perform the task.

The responses documented about the last question on the post-survey ("Please tell us something about PixelSpreadsheet or the videos that we could fix to make them work better for you and your students.") revealed that the program's interface may not be as intuitive as originally thought. Some notable responses on the surveys say to prompt users to use small pictures. Others mentioned that the videos did not explain things step-by-step, and that it assumed too much from the user.

While the videos were created to be step-by-step instructions, they assumed that the teachers would be more familiar with spreadsheet programs than they were. Some wanted videos on how to use Excel. The written directions could also be improved. One

survey mentioned that the problem was more of a lack of Excel/LibreOffice knowledge than difficulty with the image manipulation program itself. The differences between Excel and LibreOffice's Spreadsheet program may have contributed to this as well.

The task checkoff sheet helped answer the second question. According to the post-survey, (7/8) said that the videos were helpful in completing the task, and (1/8) said they were not. From the task sheets, (6/8) were able to accomplish at least two of the tasks, and (5/8) were able to complete all three. Further analysis reveals that the one who completed two or more tasks, (5/6) of them are STEM educators. From what I observed during the session, most of the participants had trouble maneuvering through LibreOffice. Again, the issue of the video using Excel and the participants using LibreOffice's Calc program could contribute to the problems as well.

Six of the eight participants said they would use PixelSpreadsheet in the classroom, while (2/8) said they would not. The two who replied with a "no" stated, in their response, they would not be able to because the program was "too slow", and involved a lot of work (pertaining to how to actually manipulate the image), it wouldn't interest their students. The issue here is that they might not have understood the reason of the testing. PixelSpreadsheet is not like Photoshop; it was not meant to be like Photoshop. It is meant to teach students (data abstraction) rudimentary parts of an image, which is why it is important to show each individual pixel in a picture.

How much did they use the videos when doing the tasks? Well, the video recording was incomplete. Participants were asked to press HyperCam's recording button, but six of the participants had forgotten to. The video surveillance analysis is not feasible because there is not enough information.

As for the last question, the background of the participants greatly influenced the results. By analyzing the demographic and pre-survey results alongside the task sheets, the results show that out of the eight teachers, (6/8) have a STEM background, one them was a music educator and the last one is economics. Most have had experience with

image manipulation (6/8), and the ones that did taught computer science (5/6) or mathematics (1/6). Five out of eight participants finished all three tasks, (1/8) finished two of the tasks, (1/8) finished one task, and (1/8) did not complete any task. The ones who finished two or more tasks, (5/6) of them are STEM educators. The ones with STEM backgrounds, especially ones who are already involved with computer science, were able to succeed in completing the tasks better than the ones who do not share the same educational background. Meaning, that the program and videos were overall not successful in introducing these concepts to people who do not already have experience in computer science or image manipulation.

CHAPTER 5

CONCLUSION

Video tutorials help in remembering general concepts of PixelSpreadsheet, but do not cover enough of how to use functions in Excel/LibreOffice. Video tutorials were helpful in teaching the subjects the basics of pixel and images, but switching between two programs (PixelSpreadsheet and LibreOffice) to perform each task proved to be too difficult and caused a few subjects to not finish. The tutorial videos provide scaffolding to the user in order to help them use the program. However, the specific content found in the video did not match exactly what the participant had to use in order to program the tasks. Therefore, a gap was formed, and the overall effectiveness of the video was overshadowed by the disconnect between the programs used in the video (Microsoft Excel) and the program used in the testing session (LibreOffice). Even though that was primarily the problem, another issue contributed to the conclusion.

Having to switch out between finding pictures and spreadsheets from the computer files to the PixelSpreadsheet program increased the gap between the program and the tutorial videos. The videos had provided enough scaffolding to help participants understand key parts of their tasks, but the differences in spreadsheet programs and the overall confusion the spreadsheet issues caused some participants to not finish the tasks. Based on survey responses, teachers that were not STEM teachers did not develop an understanding of the computer science concepts, and were not able to finish the tasks. This shows that the black-box structure never changed into a glass-box, ultimately disabling the non-STEM participants from becoming fully independent of the videos.

CHAPTER 6

FUTURE WORK

In the future, I hope to aid in developing a better interface for PixelSpreadsheet, one that includes a built-in spreadsheet file for speedier testing and results. This will allow users to become more comfortable in knowing what buttons to press and menus to follow since it would be in one program. Testing a newer PixelSpreadsheet will help in spreading computing literacy to all who embrace it.

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